

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
7 February 2002 (07.02.2002)

PCT

(10) International Publication Number  
WO 02/10550 A1

(51) International Patent Classification<sup>7</sup>: E21B 23/00.  
23/08, 29/00

RING, Lev [RU/US]; 14126 Heatherhill Place, Houston,  
TX 77077 (US).

(21) International Application Number: PCT/US01/23815

(74) Agents: MATTINGLY, Todd et al.; Haynes and Boone,  
LLP, 1000 Louisiana, Suite 4300, Houston, TX 77002  
(US).

(22) International Filing Date: 27 July 2001 (27.07.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/221,645 28 July 2000 (28.07.2000) US

(71) Applicant (for all designated States except US): ENVEN-  
TURE GLOBAL TECHNOLOGY [US/US]; 16200 A.  
Park Row, Houston, TX 77084 (US).

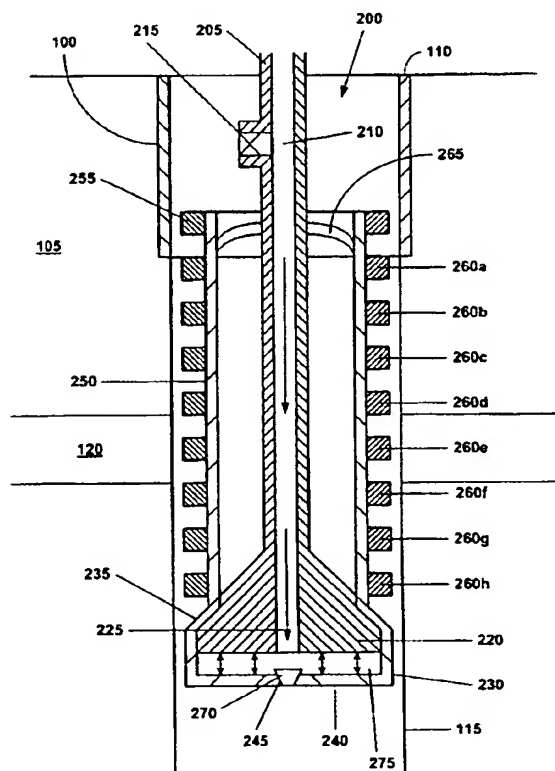
(81) Designated States (national): AE, AG, AI, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU,  
CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GI, GM,  
HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK,  
LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX,  
MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL,  
TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM,  
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian  
patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European  
patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE,  
IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF,

[Continued on next page]

(54) Title: LINER HANGER WITH STANDOFFS

(57) Abstract: An apparatus and method for  
forming or repairing a wellbore casing (110) by  
radially expanding a tubular liner (250) having  
standoffs (260a-h).



WO 02/10550 A1

BEST AVAILABLE COPY



CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, — with amended claims  
TG).

**Published:**

--- with international search report

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

LINER HANGER WITH STANDOFFS  
Cross Reference To Related Applications

This application claims the benefit of the filing date of U.S. provisional patent application serial number 60/221,645, attorney docket number 25791.46, filed on 7/28/2000, the disclosure of which is  
5 incorporated herein by reference.

This application is related to the following co-pending applications:  
(1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney  
10 docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number  
15 25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, attorney docket number  
20 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number 60/121,907, attorney docket number 25791.16, filed on  
25 2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number  
30 25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106,

attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket number 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37, filed on 10/12/1999; (17) U.S. provisional patent application serial number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999; and (18) U.S. provisional patent application number \_\_\_\_\_, attorney docket number 25791.45, filed on \_\_\_\_\_, the disclosures of which are incorporated herein by reference.

#### Background of the Invention

This invention relates generally to wellbore casings, and in particular to wellbore casings that are formed using expandable tubing.

Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to

prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming wellbores and wellheads.

#### Summary of the Invention

According to one aspect of the present invention, a method of forming a casing in a wellbore having a cased section and an open hole section is provided that includes positioning a tubular liner within the wellbore, overlapping the tubular liner and the cased section, centering the tubular liner within the wellbore, and radially expanding the tubular liner into contact with the cased section.

According to another aspect of the present invention, a radially expandable tubular member for repairing an opening in a wellbore casing is provided that includes a tubular member, and one or more standoffs coupled to the exterior surface of the tubular member.

According to another aspect of the present invention, an apparatus for repairing an opening in a wellbore casing is provided that includes a tubular support member including a first passage, an expansion cone coupled to the tubular support member including a second passage  
5 fluidically coupled to the first passage, an expansion cone launcher coupled to the expansion cone including a shoe having an exhaust passage, and an expandable tubular member coupled to the expansion cone launcher including one or more standoffs.

According to another aspect of the present invention, an apparatus  
10 is provided that includes a wellbore including a preexisting casing and an open hole section, and a radially expanded tubular member coupled to the preexisting casing including one or more standoffs.

#### Brief Description of the Drawings

FIG. 1 is a cross-sectional view illustrating a wellbore including a  
15 wellbore casing and an open hole section that traverses a porous subterranean layer.

FIG. 2 is a fragmentary cross-sectional view illustrating the introduction of an apparatus for casing the open hole section of the wellbore of FIG. 1.

20 FIG. 3 is a fragmentary cross-sectional view illustrating the injection of a fluidic material into the apparatus of FIG. 2.

FIG. 4 is a fragmentary cross-sectional view illustrating the placement of a plug into the exhaust passage of the shoe of the apparatus of FIG. 3.

25 FIG. 5 is a fragmentary cross-sectional view illustrating the pressurization of the interior portion of the apparatus below the expansion cone of FIG. 4.

FIG. 6 is a fragmentary cross-sectional view illustrating the completion of the radial expansion of the tubular member of the apparatus  
30 of FIG. 5.

FIG. 7 is a fragmentary cross-sectional view illustrating the removal of the shoe from the apparatus of FIG. 6.

#### Detailed Description of the Illustrative Embodiments

An apparatus and method for casing an open hole section of a wellbore within a subterranean formation is provided. The apparatus and method provides a system for casing an open hole section of a wellbore within a subterranean formation in which a tubular member having a plurality of radially oriented standoffs is radially expanded into contact with the preexisting wellbore casing and the open hole section. The standoffs provided on the exterior surface of the tubular member preferably position the tubular member away from the interior walls of the open hole section during the radial expansion process. In this manner, the tubular member does not adhere to underpressurized sections of the open hole section of the wellbore. In this manner, the process of radial expansion is more reliable.

Referring initially to Fig. 1, a wellbore 100 positioned within a subterranean formation 105 includes a preexisting casing 110 and an open hole section 115 that traverses an porous region 120. When the operating pressure within the wellbore  $P_{\text{BORE}}$  is greater than the operating pressure within the porous region  $P_{\text{PORE}}$ , fluidic materials will flow from the wellbore 100 into the porous region 120. As a result of the flow of fluidic materials from the wellbore 100 into the porous region 120, downhole equipment will tend to adhere to, or at least be drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. This can have serious and adverse consequences when radially expanding a tubular member in such an operating environment.

Referring to Fig. 2, an apparatus 200 for forming a wellbore casing in the open hole section of the wellbore 100 may then be positioned within the wellbore in an overlapping relationship with the lower portion of the preexisting wellbore casing 110.

The apparatus 200 includes a tubular support member 205 having a longitudinal passage 210 and a transverse passage 215 that is coupled to an expansion cone 220 having a longitudinal passage 225 that is fluidically coupled to the longitudinal passage 210. The expansion cone 220 is at least partially received within an expansion cone launcher 230 that includes a thin-walled annular member 235 and a shoe 240 having an exhaust passage 245. An expandable tubular member 250 extends from the expansion cone launcher 230 that includes a sealing member 255 and a plurality of standoffs 260a-260h affixed to the exterior surface of the expandable tubular member. In a preferred embodiment, the standoffs 260 are fabricated from a resilient material. A sealing cup 265 is attached to the exterior surface of the tubular support member 205 for preventing foreign materials from entering the interior of the expandable tubular member 250.

In a preferred embodiment, the apparatus 200 is provided as disclosed in one or more of the following: (1) U.S. patent application serial no. 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney docket number 25791.9, filed on 11/16/1998, (2) U.S. patent application serial no. 09/454,139, attorney docket number 25791.3.02, filed on 12/3/1999, which claimed benefit of the filing date of U.S. provisional patent application serial number 60/111,293, filed on 12/7/1998, (3) U.S. patent application serial number 09/502,350, attorney docket number 25791.8.02, filed on 2/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/119,611, attorney docket number 25791.8, filed on 2/11/1999, (4) U.S. patent application serial number 09/510,913, attorney docket number 25791.7.02, filed on 2/23/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,702, attorney docket number 25791.7, filed on 2/25/1999, (5) U.S. patent application serial number 09/511,941, attorney



docket number 25791.16.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application number 60/121,907, attorney docket number 25791.16, filed on 2/26/1999, (6) U.S. patent application serial number 09/523,460, attorney docket number 25791.11.02, filed on 3/10/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/124,042, attorney docket number 25791.11, filed on 3/11/1999, (7) U.S. patent application serial number 09/559,122, attorney docket number 25791.23.02, filed on 4/26/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/131,106, attorney docket number 25791.23, filed on 4/26/1999, (8) U.S. patent application serial number \_\_\_\_\_, attorney docket number 25791.17.02, filed on \_\_\_\_\_, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/137,998, attorney docket number 25791.17, filed on 6/7/1999, (9) U.S. provisional patent application serial number 60/143,039, attorney docket number 25791.26, filed on 7/9/1999, (10) U.S. provisional patent application serial number 60/146,203, attorney docket number 25791.25, filed on 7/29/1999, the disclosures of which are incorporated by reference; (11) U.S. provisional patent application serial number 60/183,546, attorney docket number 25791.10, filed on 2/18/2000; (12) U.S. patent application serial number 09/512,895, attorney docket number 25791.12.02, filed on 2/24/2000, which claimed the benefit of the filing date of U.S. provisional patent application serial number 60/121,841, attorney docket number 25791.12, filed on 2/26/1999; (13) U.S. provisional patent application serial number \_\_\_\_\_, attorney docket number 25791.38, filed on 6/19/2000; (14) U.S. provisional patent application serial number 60/162,671, attorney docket number 25791.27, filed on 11/1/1999; (15) U.S. provisional patent application serial number 60/159,039, attorney docket number 25791.36, filed on 10/12/1999; (16) U.S. provisional patent application serial number 60/159,033, attorney docket number 25791.37,

filed on 10/12/1999; and (17) U.S. provisional patent application serial number 60/165,228, attorney docket number 25791.39, filed on 11/12/1999, the disclosures of which are incorporated herein by reference.

As illustrated in Fig. 2, during placement of the apparatus 200 within the wellbore 100, fluidic materials displaced by the apparatus 200 are conveyed through the longitudinal passages 210 and 225 to the transverse passage 215. In this manner, surge pressures during the placement of the apparatus 200 within the wellbore 100 are minimized. Furthermore, as illustrated in Fig. 2, the apparatus 200 is preferably initially positioned with upper portion of the tubular member 250 in opposing relation to the lower portion of the preexisting wellbore casing 110. In this manner, the upper portion of the tubular member 250 may be radially expanded into contact with the lower portion of the preexisting wellbore casing 110. In a preferred embodiment, during the placement of the apparatus 200 within the wellbore 100, the standoffs 260a-260h prevent the apparatus 200 from adhering to, or being drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. In this manner, the apparatus 200 is approximately centered within the wellbore 100.

As illustrated in Fig. 3, the transverse passage 215 may then be closed and fluidic materials injected into the apparatus 200 through the longitudinal passage 210. In this manner, any blockages within any of the passages 210, 225, and 245 may be detected by monitoring the operating pressure whereby an increase in operating pressure above nominal, or predetermined, conditions may indicate a blockage of one of the passages.

As illustrated in Fig. 4, a plug 270 or other conventional stop member may then be introduced into the fluidic materials injected into the apparatus 200 through the passage 210, and the plug 270 may be positioned within the exhaust passage 245. In this manner, the exhaust passage 245 may be sealed off. Thus, continued injection of fluidic

materials into the apparatus 200 through the passage 210 may thereby pressurize a region 275 below the expansion cone 220.

As illustrated in Figs. 5 and 6, continued pressurization of the region 275 causes the expansion cone 220 to radially expand the expandable tubular member 250 off of the expansion cone. In this manner, the upper portion of the radially expanded tubular member 250 is coupled to the lower portion of the preexisting wellbore casing 110. In a preferred embodiment, during the radial expansion process, the tubular support member 205 is raised out of the wellbore 100.

In a preferred embodiment, throughout the radial expansion process, the standoffs 260a-260h prevent the exterior surface of the apparatus 200 from adhering to, or being drawn toward, the interior surface of the wellbore 100 in the vicinity of the porous region 120. In this manner, the apparatus 200 is preferably substantially centered within the wellbore 100. Furthermore, in this manner, the longitudinal center axis of the expansion cone 220 is preferably maintained in a position that is substantially coincident with the longitudinal center axis of the tubular member 250. In addition, in this manner, the stresses applied to the interior surface of the tubular member 250 by the axial displacement of the expansion cone 220 are substantially even. Finally, in this manner, overstressing of the tubular member 250 is prevented thereby eliminating catastrophic failure of the tubular member 250.

As illustrated in Fig. 7, the shoe 240 may then be removed using a conventional milling device.

In a preferred embodiment, upon radially expanding the expandable tubular member 250, the standoffs 260a-260h seal and isolate intervals within the open hole section 115. In several alternative embodiments, the standoffs 260 may be provided, for example, by annular members spaced along the length of the expandable tubular member 250 and/or a continuous member that is wrapped around the expandable tubular member 250 in helical fashion.

It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the apparatus 200 may be used to form and/or repair, for example, a wellbore casing, a pipeline, or a structural support.

5           Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is  
10   appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

## Claims

What is claimed is:

- 1     1.     A method of forming a casing in a wellbore having a cased section  
2     and an open hole section, comprising:  
3         positioning a tubular liner within the wellbore;  
4         overlapping the tubular liner and the cased section;  
5         centering the tubular liner within the wellbore; and  
6         radially expanding the tubular liner into contact with the cased  
7         section.
- 8     2.     The method of claim 1, wherein centering comprises:  
9         preventing the tubular liner from adhering to the open hole section  
10         of the wellbore.
- 1     3.     A radially expandable tubular member for repairing an opening in  
2     a wellbore casing, comprising:  
3         a tubular member; and  
4         one or more standoffs coupled to the exterior surface of the tubular  
5         member.
- 1     4.     An apparatus for repairing an opening in a wellbore casing,  
2     comprising:  
3         a tubular support member comprising a first passage;  
4         an expansion cone coupled to the tubular support member  
5             comprising a second passage fluidically coupled to the first  
6             passage;  
7         an expansion cone launcher coupled to the expansion cone  
8             comprising a shoe having an exhaust passage; and  
9         an expandable tubular member coupled to the expansion cone  
10         launcher comprising one or more standoffs.

- 1     5.     An apparatus, comprising:  
2             a wellbore comprising a preexisting casing and an open hole section;  
3             and  
4             a radially expanded tubular member coupled to the preexisting  
5             casing comprising one or more standoffs.
- 1     6.     A system for forming a casing in a wellbore having a cased section  
2     and an open hole section, comprising:  
3             means for positioning a tubular liner within the wellbore;  
4             means for overlapping the tubular liner and the cased section;  
5             means for centering the tubular liner within the wellbore; and  
6             means for radially expanding the tubular liner into contact with the  
7             cased section.
- 1     7.     The system of claim 6, wherein the means for centering comprises:  
2             means for preventing the tubular liner from adhering to the open  
3             hole section of the wellbore.

## AMENDED CLAIMS

[received by the International Bureau on 16 January 2002 (16.01.02);  
original claims 1-7 cancelled; claims 8-19 added (7 pages)]

1 5. [DELETED]

1 6. [DELETED]

1 7. [DELETED]

1 8. In a wellbore that traverses a subterranean formation and includes a cased  
2 section having a wellbore casing and an uncased section that traverses a porous  
3 subterranean zone, wherein the operating pressure of the wellbore is greater than  
4 the operating pressure of the porous subterranean zone, a method of coupling a  
5 tubular liner to the wellbore casing of the cased section of the wellbore,  
6 comprising:

7 positioning a solid tubular liner and an expansion cone within the wellbore  
8 with the solid tubular liner overlapping the wellbore casing;  
9 during the positioning of the solid tubular liner within the wellbore,  
10 preventing the portion of the solid tubular liner that does not  
11 overlap with the wellbore casing from contacting the porous  
12 subterranean zone of the uncased section of the wellbore;  
13 radially expanding the solid tubular liner by injecting a fluidic material  
14 into the tubular liner to pressurize the interior of the solid tubular  
15 liner and displace the expansion cone relative to the solid tubular  
16 liner; and  
17 preventing the portion of the solid tubular liner that does not overlap with  
18 the wellbore casing from contacting the porous subterranean zone  
19 of the uncased section of the wellbore during the radial expansion of  
20 the portion of the solid tubular liner that does not overlap with the  
21 wellbore casing.

1 9. The method of claim 8, further comprising:  
2 during the positioning of the solid tubular liner within the wellbore,  
3 preventing the portion of the solid tubular liner that does not  
4 overlap with the wellbore casing from adhering to the porous  
5 subterranean zone of the uncased section of the wellbore; and

6 preventing the portion of the solid tubular liner that does not overlap with  
7 the wellbore casing from adhering to the porous subterranean zone  
8 of the uncased section of the wellbore during the radial expansion of  
9 the portion of the solid tubular liner that does not overlap with the  
10 wellbore casing.

1 10. In a wellbore that traverses a subterranean formation, the wellbore  
2 including a cased section having a wellbore casing and an uncased section, a  
3 method of coupling a tubular liner to the wellbore casing of the cased section of  
4 the wellbore, comprising:  
5 positioning a solid tubular liner and an expansion cone within the wellbore  
6 with the solid tubular liner overlapping the wellbore casing;  
7 during the positioning of the portion of the solid tubular liner that does not  
8 overlap with the wellbore casing within the wellbore, maintaining  
9 the longitudinal center line of the expansion cone in a position that  
10 is substantially coincident with the longitudinal center line of the  
11 portion of the solid tubular liner that does not overlap with the  
12 wellbore casing;  
13 radially expanding the solid tubular liner by injecting a fluidic material  
14 into the tubular liner to pressurize the interior of the solid tubular  
15 liner and displace the expansion cone relative to the solid tubular  
16 liner; and  
17 maintaining the longitudinal center line of the expansion cone in a position  
18 that is substantially coincident with the longitudinal center line of  
19 the portion of the solid tubular liner that does not overlap with the  
20 wellbore casing during the radial expansion of the portion of the  
21 solid tubular liner that does not overlap with the wellbore casing.

1 11. In a wellbore that traverses a subterranean formation, the wellbore  
2 including a cased section having a wellbore casing and an uncased section, a  
3 method of coupling a tubular liner to the wellbore casing of the cased section of  
4 the wellbore, comprising:  
5 positioning a solid tubular liner and an expansion cone within the wellbore;  
6 overlapping a portion of the solid tubular liner with the wellbore casing;



7 radially expanding the solid tubular liner by injecting a fluidic material  
8 into the tubular liner to pressurize the interior of the solid tubular  
9 liner and displace the expansion cone relative to the solid tubular  
10 liner; and  
11 during the radial expansion of the portion of the solid tubular liner that  
12 does not overlap with the wellbore casing, applying substantially  
13 equal stresses to the interior surface of the portion of the solid  
14 tubular liner that does not overlap with the wellbore casing using  
15 the expansion cone.

1 12. In a wellbore that traverses a subterranean formation and includes a cased  
2 section having a wellbore casing and an uncased section that traverses a porous  
3 subterranean zone, wherein the operating pressure of the wellbore is greater than  
4 the operating pressure of the porous subterranean zone, a system for coupling a  
5 tubular liner to the wellbore casing of the cased section of the wellbore,  
6 comprising:  
7 means for positioning a solid tubular liner and an expansion cone within  
8 the wellbore with the solid tubular liner overlapping the wellbore  
9 casing;  
10 means for during the positioning of the solid tubular liner within the  
11 wellbore, preventing the portion of the solid tubular liner that does  
12 not overlap with the wellbore casing from contacting the porous  
13 subterranean zone of the uncased section of the wellbore;  
14 means for radially expanding the solid tubular liner by injecting a fluidic  
15 material into the tubular liner to pressurize the interior of the solid  
16 tubular liner and displace the expansion cone relative to the solid  
17 tubular liner; and  
18 means for preventing the portion of the solid tubular liner that does not  
19 overlap with the wellbore casing from contacting the porous  
20 subterranean zone of the uncased section of the wellbore during the  
21 radial expansion of the portion of the solid tubular liner that does  
22 not overlap with the wellbore casing.

- 1     13.   The system of claim 12, further comprising:  
2           means for during the positioning of the solid tubular liner within the  
3           wellbore, preventing the portion of the solid tubular liner that does  
4           not overlap with the wellbore casing from adhering to the porous  
5           subterranean zone of the uncased section of the wellbore; and  
6           means for preventing the portion of the solid tubular liner that does not  
7           overlap with the wellbore casing from adhering to the porous  
8           subterranean zone of the uncased section of the wellbore during the  
9           radial expansion of the portion of the solid tubular liner that does  
10          not overlap with the wellbore casing.
- 1     14.   In a wellbore that traverses a subterranean formation, the wellbore  
2     including a cased section having a wellbore casing and an uncased section, a  
3     system for coupling a tubular liner to the wellbore casing of the cased section of  
4     the wellbore, comprising:  
5           means for positioning a solid tubular liner and an expansion cone within  
6           the wellbore with the solid tubular liner overlapping the wellbore  
7           casing;  
8           means for during the positioning of the portion of the solid tubular liner  
9           that does not overlap with the wellbore casing within the wellbore,  
10          maintaining the longitudinal center line of the expansion cone in a  
11          position that is substantially coincident with the longitudinal center  
12          line of the portion of the solid tubular liner that does not overlap  
13          with the wellbore casing;  
14          means for radially expanding the solid tubular liner by injecting a fluidic  
15          material into the tubular liner to pressurize the interior of the solid  
16          tubular liner and displace the expansion cone relative to the solid  
17          tubular liner; and  
18          means for maintaining the longitudinal center line of the expansion cone in  
19          a position that is substantially coincident with the longitudinal  
20          center line of the portion of the solid tubular liner that does not  
21          overlap with the wellbore casing during the radial expansion of the  
22          portion of the solid tubular liner that does not overlap with the  
23          wellbore casing.

- 1     15.     In a wellbore that traverses a subterranean formation, the wellbore  
2     including a cased section having a wellbore casing and an uncased section, a  
3     system for coupling a tubular liner to the wellbore casing of the cased section of  
4     the wellbore, comprising:  
5         positioning a solid tubular liner and an expansion cone within the wellbore;  
6         overlapping a portion of the solid tubular liner with the wellbore casing;  
7         radially expanding the solid tubular liner by injecting a fluidic material  
8             into the tubular liner to pressurize the interior of the solid tubular  
9             liner and displace the expansion cone relative to the solid tubular  
10            liner; and  
11         during the radial expansion of the portion of the solid tubular liner that  
12             does not overlap with the wellbore casing, applying substantially  
13             equal stresses to the interior surface of the portion of the solid  
14             tubular liner that does not overlap with the wellbore casing using  
15             the expansion cone.
- 1     16.     An apparatus for coupling a tubular liner to a wellbore casing within a  
2     wellbore that traverses a porous subterranean formation, comprising:  
3         a tubular support member defining a first internal passage;  
4         an expansion cone coupled to the tubular support member defining a  
5             second internal passage fluidically coupled to the first internal  
6             passage;  
7         a tubular expansion cone launcher movably coupled to and mating with the  
8             expansion cone;  
9         a solid tubular liner coupled to an end of the tubular expansion cone  
10            launcher; and  
11         a shoe coupled to another end of the tubular expansion cone launcher  
12             including a valveable passage;  
13         means for during a positioning of the solid tubular liner within the  
14             wellbore, preventing a portion of the solid tubular liner that does  
15             not overlap with the wellbore casing from contacting the porous  
16             subterranean zone of the wellbore; and

17 means for preventing the portion of the solid tubular liner that does not  
18 overlap with the wellbore casing from contacting the porous  
19 subterranean zone of the wellbore during a radial expansion of the  
20 portion of the solid tubular liner that does not overlap with the  
21 wellbore casing.

1 17. The apparatus of claim 16, further comprising:  
2 means for during the positioning of the solid tubular liner within the  
3 wellbore, preventing the portion of the solid tubular liner that does  
4 not overlap with the wellbore casing from adhering to the porous  
5 subterranean zone of the wellbore; and  
6 means for preventing the portion of the solid tubular liner that does not  
7 overlap with the wellbore casing from adhering to the porous  
8 subterranean zone of the wellbore during the radial expansion of  
9 the portion of the solid tubular liner that does not overlap with the  
10 wellbore casing.

1 18. An apparatus for coupling a tubular liner to a wellbore casing within a  
2 wellbore, comprising:  
3 a tubular support member defining a first internal passage;  
4 an expansion cone coupled to the tubular support member defining a  
5 second internal passage fluidically coupled to the first internal  
6 passage;  
7 a tubular expansion cone launcher movably coupled to and mating with the  
8 expansion cone;  
9 a tubular liner coupled to an end of the tubular expansion cone launcher;  
10 and  
11 a shoe coupled to another end of the tubular expansion cone launcher  
12 including a valveable passage; and  
13 means for during a positioning of a portion of the solid tubular liner that  
14 does not overlap with the wellbore casing within the wellbore,  
15 maintaining a longitudinal center line of the expansion cone in a  
16 position that is substantially coincident with a longitudinal center

17 line of the portion of the solid tubular liner that does not overlap  
18 with the wellbore casing;  
19 means for maintaining the longitudinal center line of the expansion cone in  
20 a position that is substantially coincident with the longitudinal  
21 center line of the solid tubular liner during a longitudinal  
22 displacement of the expansion cone relate to the tubular liner.

1 19. An apparatus for coupling a tubular liner to a wellbore casing within a  
2 wellbore, comprising:  
3 a tubular support member defining a first internal passage;  
4 an expansion cone coupled to the tubular support member defining a  
5 second internal passage fluidically coupled to the first internal  
6 passage;  
7 a tubular expansion cone launcher movably coupled to and mating with the  
8 expansion cone;  
9 a tubular liner coupled to an end of the tubular expansion cone launcher;  
10 and  
11 a shoe coupled to another end of the tubular expansion cone launcher  
12 including a valveable passage; and  
13 means for during a radial expansion of a portion of the solid tubular liner  
14 that does not overlap with the wellbore casing, applying  
15 substantially equal stresses to the interior surface of the portion of  
16 the solid tubular liner that does not overlap with the wellbore  
17 casing using the expansion cone.

1/7

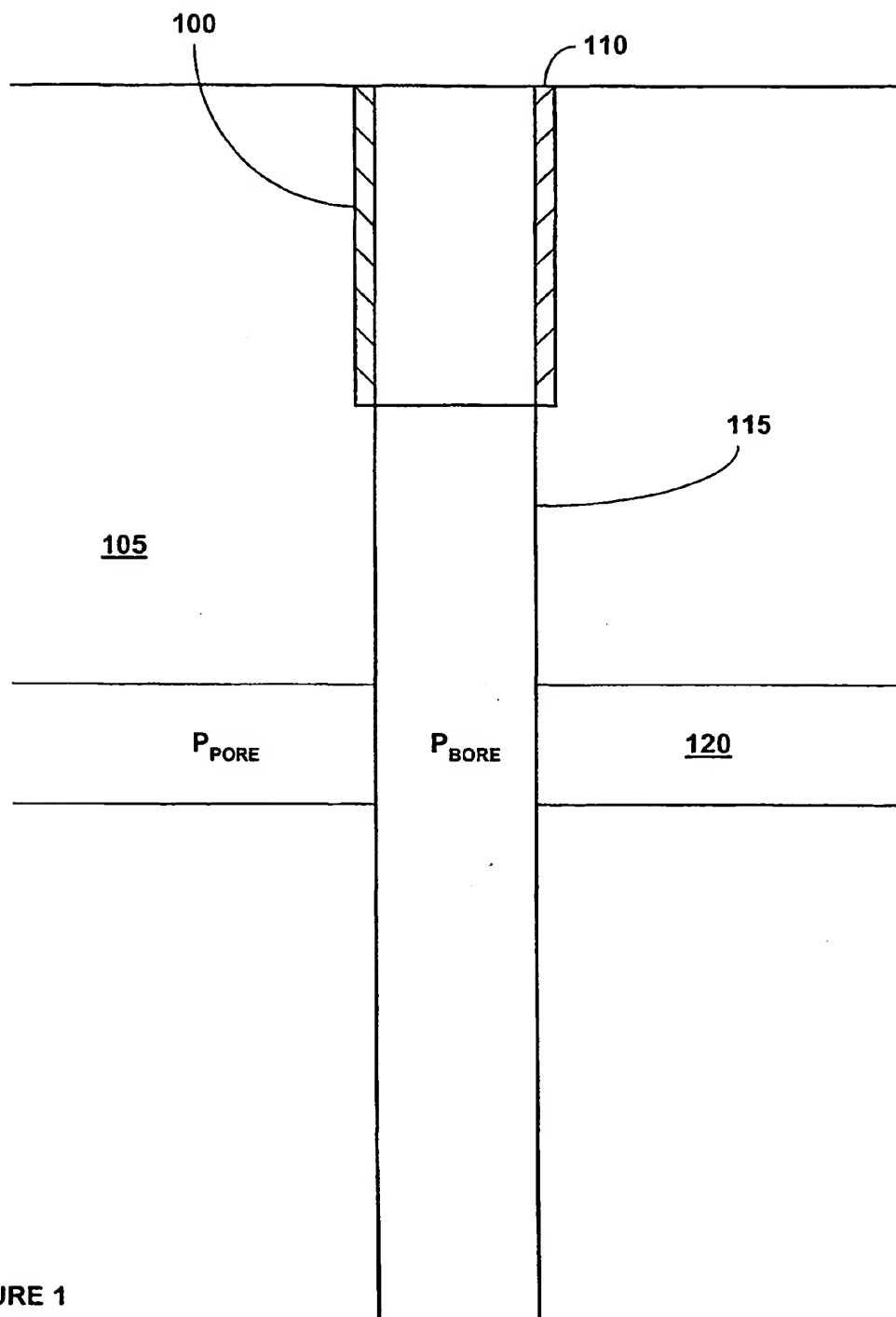


FIGURE 1

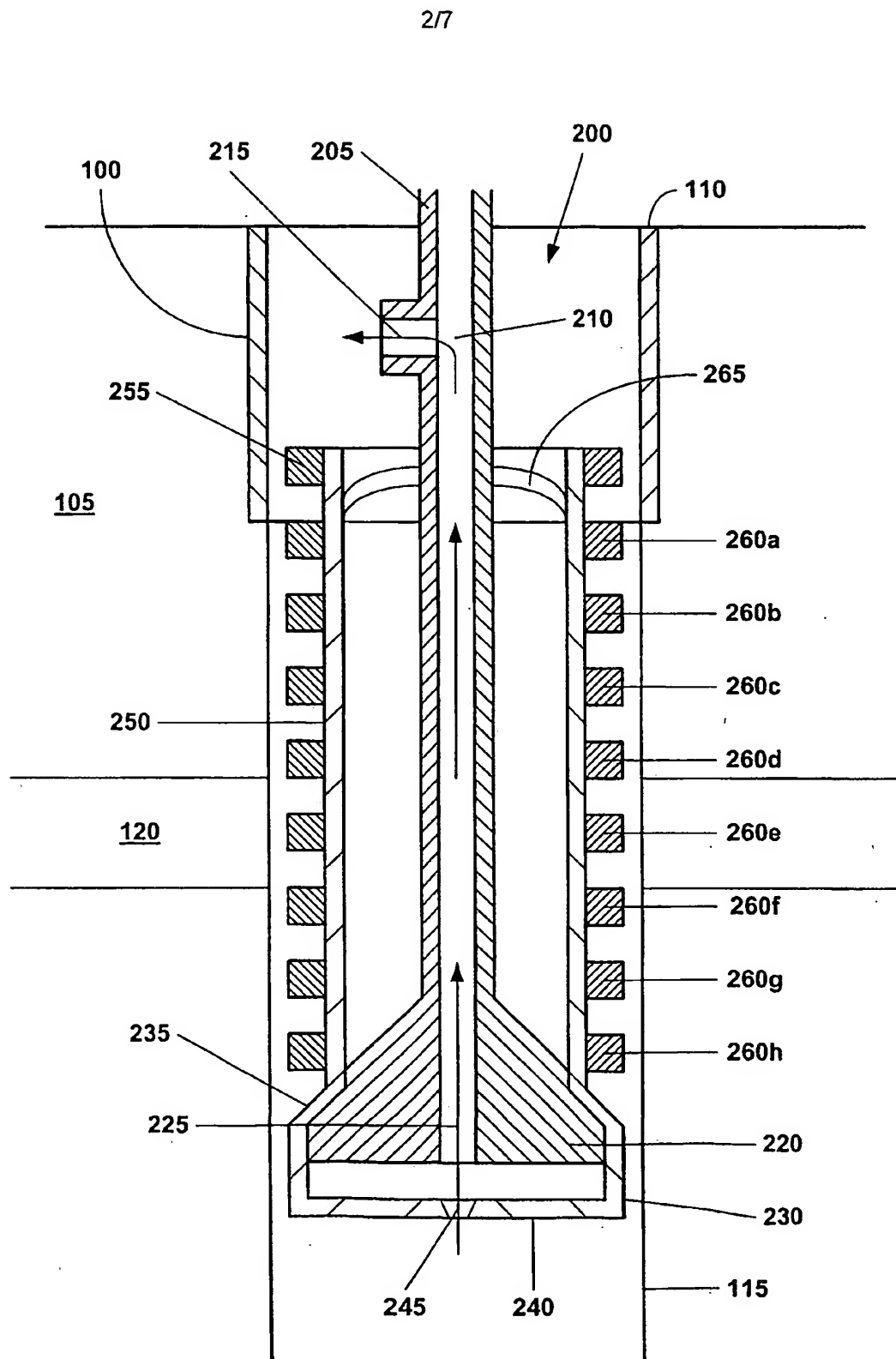


FIGURE 2

3/7

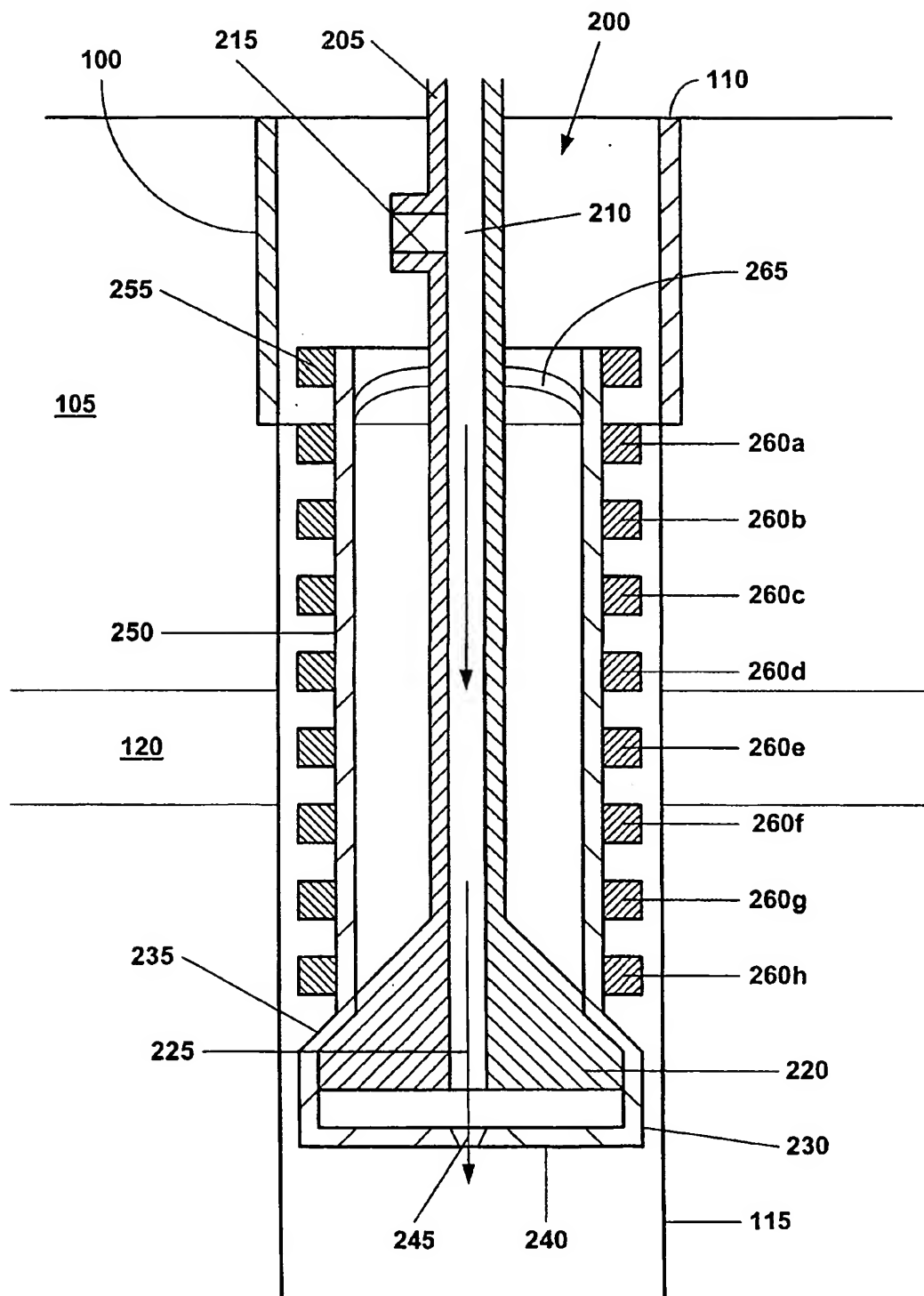


FIGURE 3



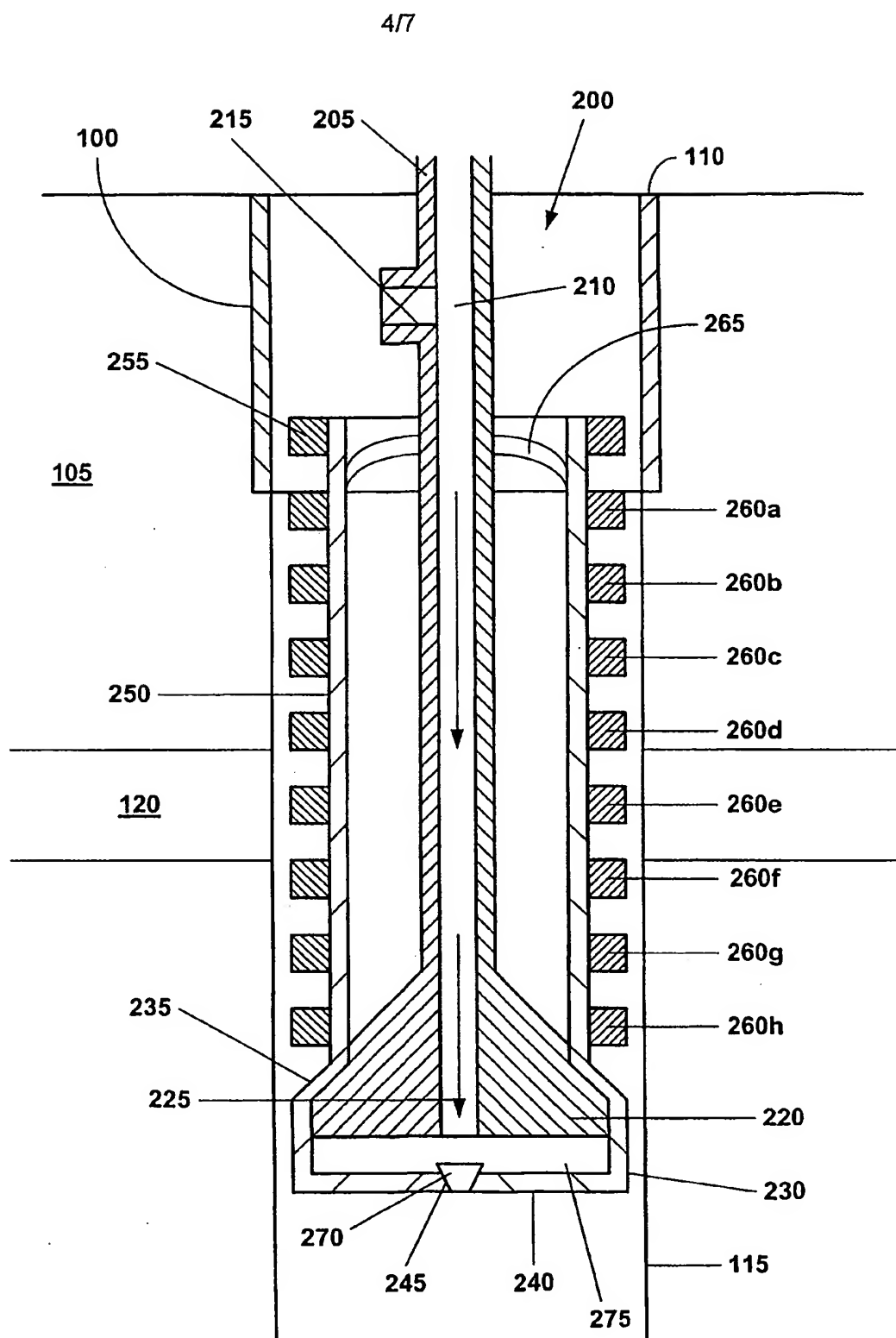


FIGURE 4

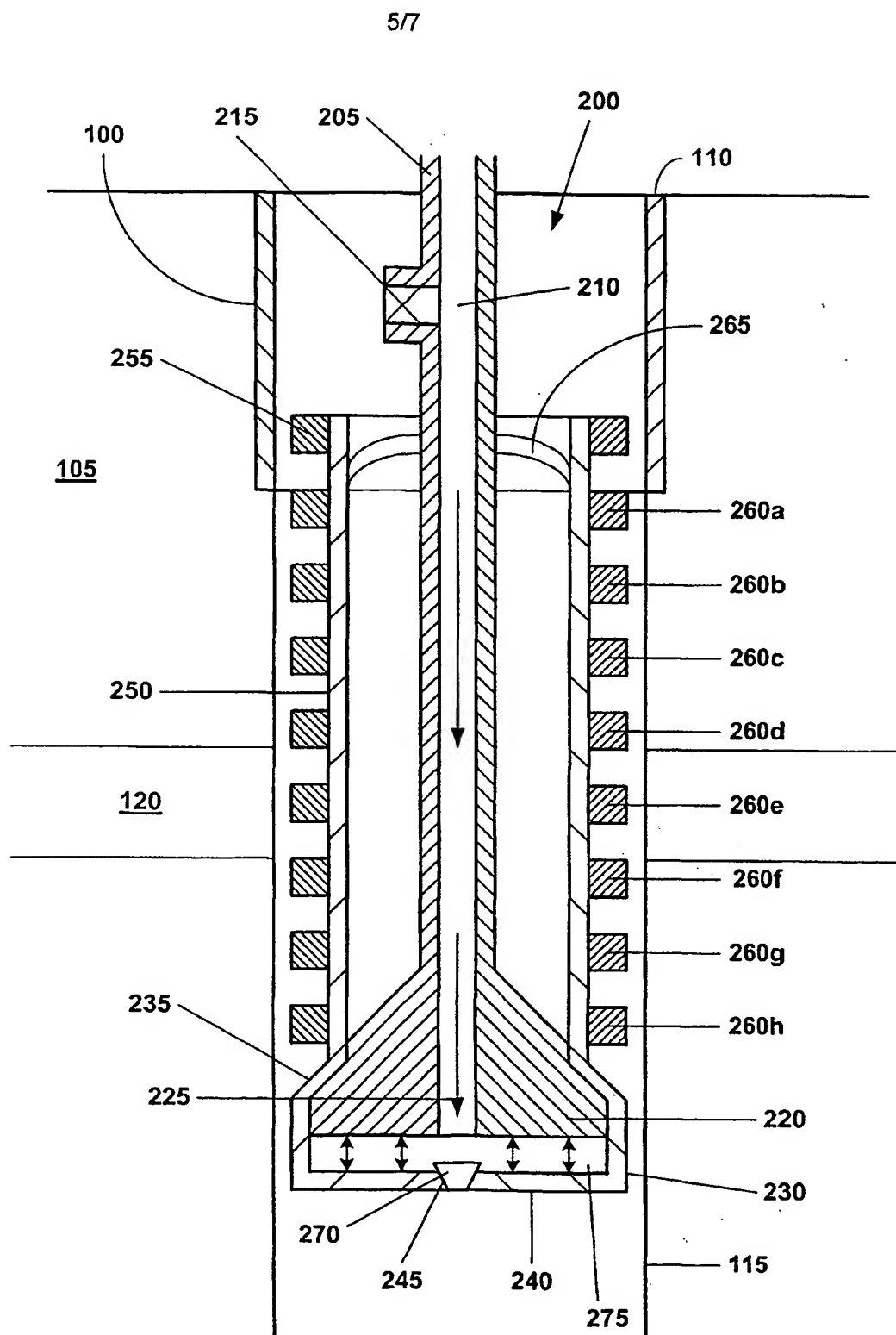


FIGURE 5

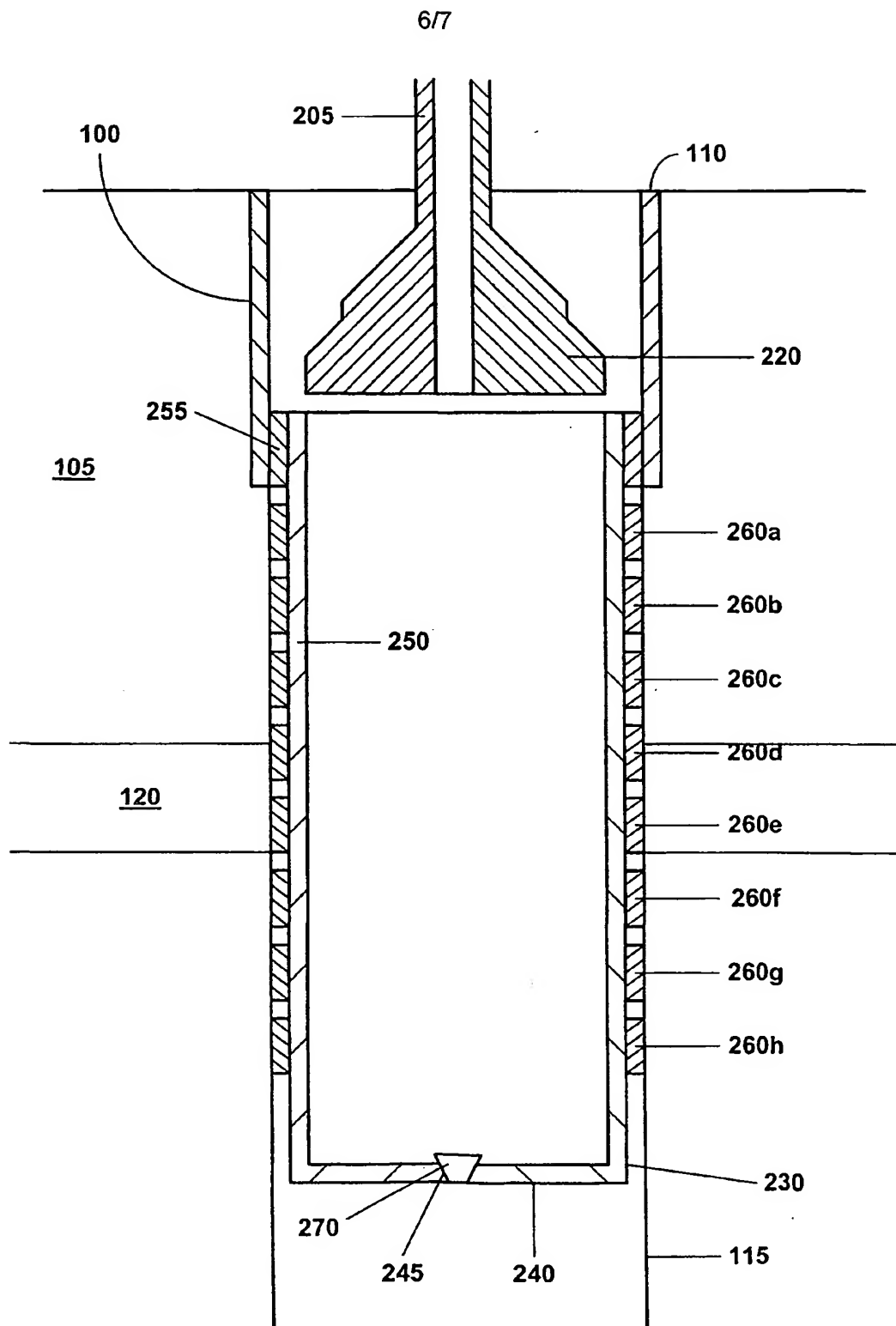


FIGURE 6

7/7

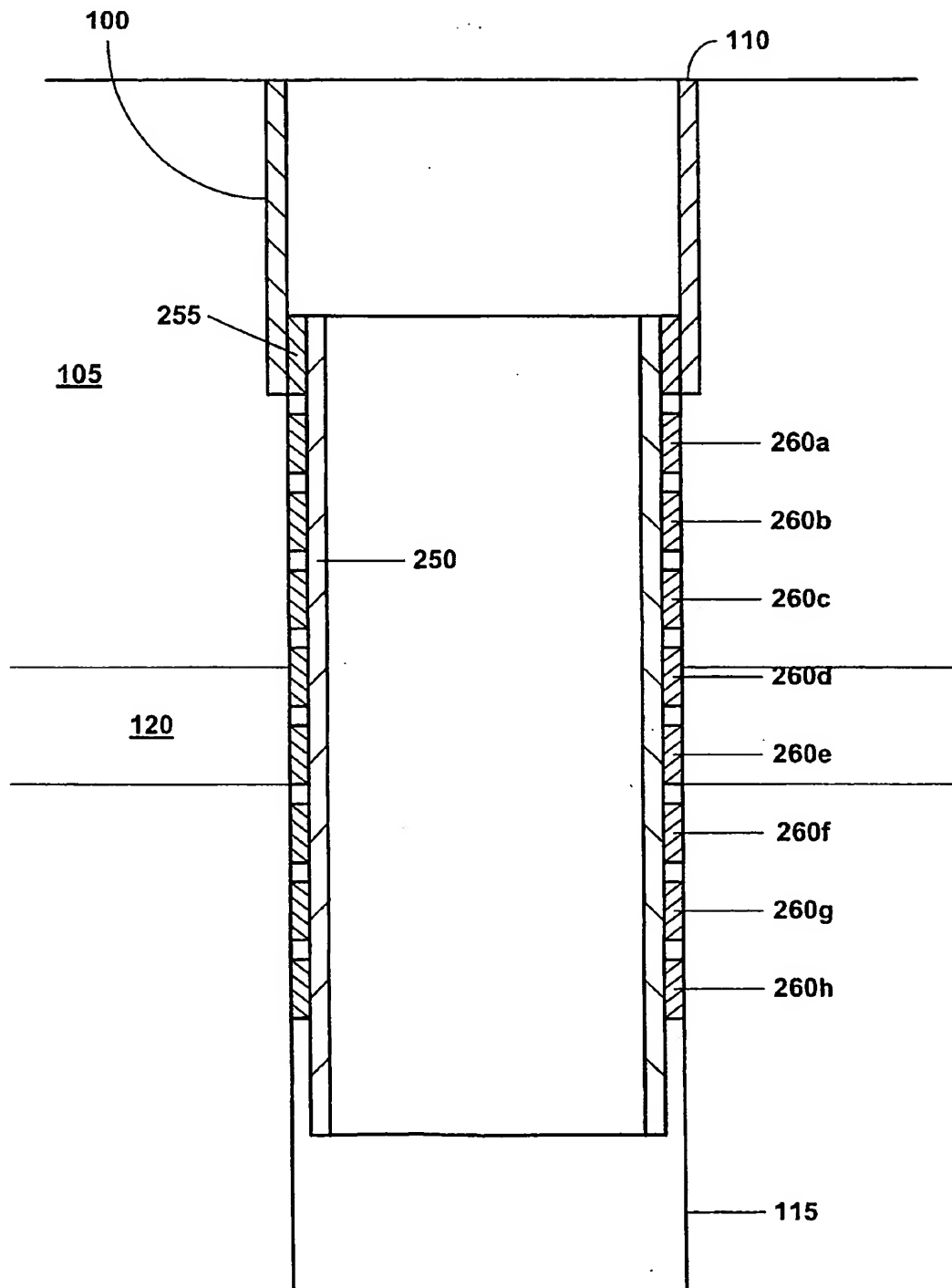


FIGURE 7

## INTERNATIONAL SEARCH REPORT

International application no.

PCT/US01/23815

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : E 21 B 23/00, 23/08, 29/00

US CL : 166/ 207, 277, 383

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 166/ 207, 277, 381, 383

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
Please See Continuation Sheet**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,085,838 A (Vercaemer et al.) 11 July 2000 (11.07.2000), Figures 2, 5-7, column 4, line 59-61, column 7, lines 6-65.	1-7
X	US 3,353,599 A (Swift) 21 November 1967 (21.11.1967), Figures 3-5, column 3, line 63 - column 4, line 5, column 4, lines 21-45, column 5, lines 11-31.	1, 2 -----
---		3, 5-7
Y		
Y	US 5,494,106 A (Gueguen et al.) 27 February 1996 (27.02.1996), Figure 5, 6, 6A, column 2, lines 53-54, column 4, lines 40-54.	3, 5-7
A	US 2,812,025 A (Teague et al.) 05 November 1957 (05.11.1957), whole document.	
A	US 2,796,134 A (Binkley) 18 June 1957 (18.06.1957), whole document	
A	US 6,012,522 A (Donnelly et al.) 11 January 2000 (11.01.2000), whole document	

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

Special categories of cited documents:	
* "A" documents defining the general state of the art which is not considered to be of particular relevance	"T" later documents published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" documents which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" documents referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" documents published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

12 October 2001 (12.10.2001)

Date of mailing of the international search report

16 NOV 2001

Name and mailing address of the ISA/US

Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703)305-3230

Authorized officer

David J. Bagnell

Telephone No. (703) 306-4180

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US01/23815

Continuation of B. FIELDS SEARCHED Item 3:  
DERWENT, JPO, EPO

wellbore, well-bore, expand, expandable, tubular, screen, ridge, ring, seal, standoff, clasp, piston

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☒ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**